Effects of Experimental Warming and Irrigation on Water Use of Sugar Maple (Acer saccharum) in a Northern Hardwood Forest

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Introduction

• The great lakes region is expected to warm as climate change alters precipitation rates around the globe, which may increase the rates of drought during the growing season (Christensen et al. 2007).

• Tree water use could be inhibited as drought events increase because transpiration is reduced as soil moisture drops (Loaiciga 2003).

Objective: Determine the treatment effects of experimental root warming and induced drought on the water use of sugar maple (A. saccharum).

Hypothesis 1: Water uptake will decrease in warming treatment due to decreased soil moisture, compared to control.

Hypothesis 2: Water uptake will increase in irrigation and combination treatments due to increased soil moisture, compared to control.

Approach

• 33 sugar maple trees will be studied during the 2011-2013 growing season at the Ford Research Forest located south of L’Anse, Michigan.

• Water use was measured with heat dissipation sap flow sensors (Fig. 1) at variable depths (Fig. 3) in eight 10 m x 10 m plots (Fig. 2) with two replicates each of four treatments:

  1. Warming (3-4˚C increase in ambient soil temperature; Fig. 4)
  2. Irrigation (20% increase to ambient precipitation; Fig. 5)
  3. Combination of warming and irrigation
  4. Control (No warming or irrigation infrastructure)

Results

• Daily sap flux was greatest in the irrigation treatment, compared to control (Fig. 6).

• Warming treatment showed higher sap flux in the morning and lower sap flux in afternoon, compared to control (Fig. 6).

• Mean daily and mean peak sap flux density was greater than the control in all treatments and greatest in irrigation and combination treatments (Fig 7 & 8).

Discussion/Conclusions

• The data to did not support hypothesis 1. Increased rates of sap flux in the warming treatment compared to the control, may be a result of either increased xylem water viscosity or increased root respiration.

• The data supported hypothesis 2. Increased rates of sap flux in the irrigation and combination treatments, compared to control, may be a result of increased soil available water. Additionally, irrigation seemed to have the highest rates of sap flux per day (Fig. 6), which was also a result of increased soil available water.

• Overall, this study could indicate that sugar maple may increase its water use with future climate change, which could result in significantly reduced water yield in future northern hardwood forests.

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References
